A squib on anaphora and coindexing

Muskens, R.A.

Published in:
Linguistics and philosophy

Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Muskens, R. A. (2011). A squib on anaphora and coindexing. *Linguistics and philosophy*, *34*, 85-89.

Linguist and Philos (2011) 34:85–89
DOI 10.1007/s10988-011-9091-8

RESEARCH ARTICLE

A squib on anaphora and coindexing

Reinhard Muskens

Published online: 16 July 2011

Abstract There are two kinds of semantic theories of anaphora. Some, such as Heim's File Change Semantics, Groenendijk and Stokhof's Dynamic Predicate Logic, or Muskens' Compositional DRT (CDRT), seem to require full coindexing of anaphora and their antecedents prior to interpretation. Others, such as Kamp's Discourse Representation Theory (DRT), do not require this coindexing and seem to have an important advantage here. In this squib I will sketch a procedure that the first group of theories may help themselves to so that they can interleave interpretation and coindexing in DRT's way.

Keywords Dynamic semantics · Anaphora · Coindexing

1 Introduction

Dynamic theories of context change and anaphora come in two flavours. Some require all input to the semantic component to come with a full coindexing of anaphoric elements and their antecedents and some do not. The second category is exemplified by Discourse Representation Theory (DRT, Kamp and Reyle 1993), which considers anaphora resolution to be an integral part of semantics, while the first category includes Heim's (1982) File Change Semantics, Groenendijk and Stokhof's (1991) Dynamic Predicate Logic and my own Compositional DRT (CDRT, Muskens 1996). It seems that DRT has the advantage here, as its resolution-on-the-fly perspective is computationally attractive and far more plausible than the

R. Muskens (✉)
Department of Philosophy, Tilburg University, 5037 AB, Tilburg,
The Netherlands
e-mail: r.a.muskens@uvt.nl

coindex-first idea. But resolution-on-the-fly is available to the other theories as well, as I will argue here.

2 Interleaving interpretation and coindexing

Let us start by drawing a distinction between the declarative and the algorithmic aspects of any linguistic theory. More often than not a linguist can concentrate on the former, leaving procedural and performative aspects out of consideration. Those interested in characterising aspects of Universal Grammar, for example, typically will not focus on performance related matters and many who are working in a framework such as LFG or HPSG will be happy to specify a class of well-formed expressions without bothering to give a corresponding algorithm for parsing or generation. Showing that such algorithms exist and investigating their properties can often be left to the computationally oriented. A grammar can be completely independent from any algorithm realising it.

In semantics there is a similar analytic distinction between specifying a relation between form and meaning and giving an interpretation procedure, i.e. an algorithm that yields a meaning representation when given a linguistic form. DRT gives specification and procedure in one combined theory, but the other theories mentioned above are best interpreted as only giving a specification. How they can be provided with a computationally plausible procedural component will be sketched here. The point will be illustrated on the basis of Muskens (1996), because this version of the coindexing theory comes with a technical property that is convenient, but mildly adapted versions of the other theories should be amenable to the same treatment.

The coindex-first model of interpretation suggested (but not entailed) by the presentation of CDRT in Muskens (1996) takes an input such as the one in (1a), indexes it, so that, say, (1e) is obtained, and then compositionally translates a Logical Form of the result. A possible end product is (1f) in the case of this example, but the indexing procedure in the first step remains a bit of a mystery. Proponents of DRT reasonably object that anaphora resolution is subject to semantic constraints, that explaining these constraints is a crucial part of the theory, and that assuming inputs to come with correct indices therefore begs an important question.

(1) a. A girl adores a boy who ignores every woman. She bores him.
b. A^1 girl adores a^2 boy who ignores every^3 woman. $\mathrm{She}_{?4}$ bores $\mathrm{him}_{?5}$.
c. $[u_1u_2 \mid \mathit{girl}\ u_1,\ \mathit{boy}\ u_2, [u_3 \mid \mathit{woman}\ u_3] \Rightarrow [\mathit{ignore}\ u_2u_3],$
$\mathit{adore}\ u_1u_2,\ \mathit{bore}\ v_4v_5]$
d. $\{?4 := 1, ?5 := 2\}$
e. A^1 girl adores a^2 boy who ignores every^2 woman. She_1 bores him_2.
f. $[u_1u_2 \mid \mathit{girl}\ u_1,\ \mathit{boy}\ u_2,\ [u_3 \mid \mathit{woman}\ u_3] \Rightarrow [\mathit{ignore}\ u_2u_3],$
$\mathit{adore}\ u_1u_2,\ \mathit{bore}\ u_1u_2]$

It is not difficult, however, to provide CDRT with an interpretation procedure that comes very close to that of DRT, provided a minor addition to the lexicon is accepted. In order to explain it, let us start with (1a) again. In (1b) this short text is provided with indices, but there is no *co*indexing going on. All possible antecedents are indexed with distinct superscripts, while anaphoric elements all get a distinct *variable* index ?*n*, the idea being that the values of these variable indices are to be established later.

At this point the compositional translation mechanism can kick in, on condition that the new variably indexed pronouns are given a lexical translation. What translations should these pronouns get? In CDRT discourse referents u_n are constants of a certain type π which denote objects called *pigeon-holes* or *registers*. Pigeon-holes are objects in the models of the theory, but they are objects that mimick the behaviour of *variables*, just like the memory locations in a computer are (physical) objects that are designed to behave just like variables. So, speaking very loosely, the u_n are *constants* referring to *variables* and we can also have *variables* that range over variables (objects of type π). In Muskens (1996) these variables ranging over variables are typically denoted with the letter v.

In order to be able to translate forms such as (1b), we stipulate that pronouns indexed with ?*n* are to be translated as $\lambda P.Pv_n$, the Montague Lifts of the variables v_n.[1] Together with the usual rules of CDRT this assignment leads to the translation in (1c), a DRS with two unresolved discourse referents, v_4 and v_5, which now need to be resolved. At this point in the process semantic *and* syntactic constraints on this resolution are available. The former can be read off from (1c); the latter from the linguistic representation of (1b). That ?4 cannot be resolved as 3 in this case (with simultaneous unification of v_4 with u_3) follows from the usual semantic accessibility constraints, for example.[2] It is possible to arrive at the unification in (1d), which leads to (1e) and (1f) in the obvious way.[3] We now have arrived at an interpretation of the text in (1a) but in the process we also have enriched this text with a coindexation of anaphoric elements with their antecedents.

Let us take a step back to obtain a wider perspective. The process just described instantiates a more general strategy in computational linguistics. It is well known that a main bottleneck for processing language is its massive ambiguity. Sentences usually come with more than one parse tree and surface trees usually come with many LF trees and/or semantic representations. Disambiguation more often than not requires semantic information, as is the case with anaphora, but also with alternative scopings and attachments. So it may seem we are in a predicament, because obtaining semantic information in its turn seems to require fully disambiguated structures. If semantics needs disambiguation but disambiguation needs semantics, how can we progress?

[1] The reason to take Montague Lifts of the variables in question here, rather than just the variables themselves, is a desire to remain fully compatible with Muskens (1996). Adding a Lifting rule to the rules T_1–T_5 of that paper, together perhaps with other type shifting rules, would be a good (and in fact better) alternative and would make it possible to use the v_n as lexical translations directly.

[2] At this point syntactic constraints arising from the Binding Theory (Chomsky 1981) or from the requirement that a pronoun agrees with its antecedent are available and may exclude other resolutions. There is no attempt to relegate *all* resolution information to the semantic component, as in Kamp and Reyle (1993).

[3] In general, more than one resolution may be compatible with all constraints.

A general solution, often chosen and also chosen here, is to represent ambiguity itself. Processing can then be done on the basis of 'underspecified' representations and disambiguation can be postponed. One way to obtain underspecified representations is to work with *descriptions* of linguistic structures instead of those structures themselves. Descriptions need not be fully specified and many different structures can satisfy the same description. This idea can be traced back at least as far as Marcus et al. (1983), who replace linguistic trees by tree descriptions (a move which then facilitates left to right parsing). The Underspecified DRT of Reyle (1993) and more recent accounts of discourse phenomena such as Asher and Lascarides (2003), van Leusen and Muskens (2003), and van Leusen (2007) are all based on some form of underspecification with the help of descriptions. Here I have chosen a somewhat different approach, as (1b) and (1c) are underspecified representations, but it would be stretching things to say that they are descriptions of anything.

3 Conclusion

I have shown that the CDRT specification of the form-meaning relation, which was originally given in terms of fully coindexed inputs, is compatible with a procedure in which interpretation and indexing are interleaved and coindexing is deferred to a moment where the semantic information that is needed is available. The treatment, which uses underspecification of linguistic information, can be extended to other 'coindex-first' theories, provided they also defer coindexing in some way. A linguistic theory may specify its content in a way that seems computationally naive and yet be compatible with procedures that are not.

Acknowledgements I would like to thank Corien Bary, one of whose many excellent questions about using Compositional DRT in theorizing about aspect in Ancient Greek led me to write this squib. See Bary (2009) for some of her results. The anonymous referees provided me with first-rate feedback.

References

Asher, N., & Lascarides, A. (2003). *Logics of conversation*. Cambridge: Cambridge University Press.

Bary, C. (2009). *Aspect in ancient Greek: A semantic analysis of the aorist and imperfective*. PhD thesis, Radboud University Nijmegen.

Chomsky, N. (1981). *Lectures on government and binding*. Dordrecht: Foris.

Groenendijk, J., & Stokhof, M. (1991). Dynamic predicate logic. *Linguistics and Philosophy, 14,* 39–100.

Heim, I. (1982). *The semantics of definite and indefinite noun phrases*. PhD thesis, Umass, Amherst. Published in 1989 by Garland, New York.

Kamp, H., & Reyle, U. (1993). *From discourse to logic*. Dordrecht: Kluwer.

Marcus. M. P., Hindle, D., & Fleck, M. M. (1983). D-theory: Talking about talking about trees. In *Proceedings of the 21st ACL* (pp. 129–136).

Muskens, R. A. (1996). Combining montague semantics and discourse representation. *Linguistics and Philosophy, 19*, 143–186.

Reyle, U. (1993). Dealing with ambiguities by underspecification: Construction, representation and deduction. *Journal of Semantics, 10*, 123–179.

van Leusen, N. (2007). *Description grammar for discourse*. PhD thesis, Radboud University Nijmegen.
van Leusen, N., & Muskens, R. (2003). Construction by description in discourse representation. In J. Peregrin (Ed.), *Meaning: The dynamic turn*, *volume 12 of current research in the semantics/pragmatics interface* (pp. 33–65). Amsterdam: Elsevier.